

SECTION 16452

GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.2 REFERENCE STANDARDS

Applicable only to the extent specified.

A. American Society for Testing and Materials (ASTM)

- 1. B3 Soft or Annealed Copper Wire
- 2. B8 Concentric-Lay-Stranded Copper Conductors; Hard, Medium Hard, or Soft
- 3. B33 Tinned Soft or Annealed Copper Wire for Electrical Purposes.
- 4. E699 Standard Criteria for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating Building Components in accordance w/Test Methods promulgated.

B. Federal Aviation Administration (FAA)

- 1. C-1217f Electrical Work, Interior
- 2. STD-019e Lightning Protection, Grounding, Bonding and shielding Requirements for Facilities.
- 3. Order 6950.19A Practices and Procedures for Lightning Protection, Grounding, Bonding, and Shielding Implementation.

C. National Fire Protection Association (NFPA)

- 1. 70 National electrical Code (NEC)
- 2. 780 Lightning Protection Code

D. Occupational Safety and Health Administration (OSHA)

- 1. 29 CFR 1910.7 National Recognized Testing Laboratories (NRTL)

E. Underwriters Laboratories (UL)

1. 46 7 Grounding and Bonding Equipment
2. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.

1.3 SUBMITTALS

- A. Product data for connectors and connection materials, and grounding fittings.
- B. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- C. Field tests and observation reports certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7, or a full member company of NETA.
 1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise onsite testing specified in Part 3.
- B. Comply with FAA specification C-1217f, FAA-STD-019e, and FAA Order No. 6950.19A.
- C. Comply with NFPA 70, National Electrical Code.
- D. Comply with UL 467.
- E. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials procured and installed in this Section shall be in accordance with FAA C-1217f and FAA STD-019e.

2.2 GROUNDING AND BONDING PRODUCTS

- A. Products: Of types indicated and of sizes and ratings to comply with NEC, FAA specification C-1217f, FAA-STD-019e, and FAA Order No. 6950.19A. Where types, sizes, ratings, and

quantities indicated are in excess of requirements above, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.3 WIRE AND CABLE GROUNDING CONDUCTORS

- A. Comply with Section 16120 "Wires and Cables." Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.
 - 1. Material: Copper. Use only copper wire for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone and similar materials.
 - 2. Size: Minimum allowable size shall not be less than #12 AWG, in addition to compliance with NEC.
- B. Equipment Grounding Conductors: Insulated with green color insulation.
- C. Grounding-Electrode Conductors: Stranded cable.
- D. Bare Copper Conductors: Conform to the following:
 - 1. Solid Conductors: ASTM B3.
 - 2. Assembly of Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B33.

2.4 MISCELLANEOUS CONDUCTORS

- A. Braided Bonding Jumpers: Where electrical continuity across the shock mounts is necessary, bonding jumpers shall be installed across each shock mount. Jumpers of this application should have a maximum thickness of 0.025 inch, so that the damping efficiency of the mount is not impaired. In severe shock and vibration environments, solid straps may be corrugated, or flexible wire braid may be used. Braids are to be terminated with copper ferrules.
- B. Raceway Bonding Jumpers: Copper, minimum size #6 AWG unless otherwise noted.

2.5 CONNECTOR PRODUCTS

- A. General: Listed and labeled as grounding connectors for the materials used.
- B. Pressure Connectors: High-conductivity-plated units.
- C. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

PART 3 - EXECUTION

3.1 APPLICATION

GROUNDING

A. Grounding:

1. General: FAA grounding requirements often exceed those of NEC; therefore, grounding system shall be as indicated in Contract Drawings, and as specified herein.
2. Materials procured and installed in this Section shall be in accordance with FAA C-1217f, FAA STD-019e and FAA Order 6950.19a.

B. Equipment Grounding Conductors: All metallic non-current carrying parts of electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings. Equipment grounding conductors shall be green insulated copper conductors unless otherwise indicated. When these conductors are not sized nor shown on the Contract Drawings, size them in accordance with Table 250-95 of the NEC, "Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment. In no case, however, shall these conductors be smaller than No. 12 AWG.

1. Install separate green, equipment grounding conductor for each over current device, and with all feeder and branch circuit conductors.
2. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and above, including air cleaners and heaters. Conductor to each unit device and to air duct shall be bonded.

3.2 INSTALLATION

- A. Materials procured and installed in the Section shall be in accordance with FAA C-1217f, FAA STD-019e and FAA Order 6950.19a.
- B. General: The grounding requirements exceed those of the NEC. Grounding system shall be as indicated on the contract drawings and as specified herein.
- C. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- D. Equipment Enclosure Grounding: Bare wire, wrapped around connecting screws or mounting bolts and screws is not acceptable as a grounding connection. All ground lugs shall be of a non-corrosive material suitable for use as a grounding connection, and must be compatible with the type of metal being grounded. Ground lugs shall be mounted on clean, bare metal surfaces that are free of paint, rust, etc.
- E. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

3.3 CONNECTIONS

- A. Materials procured and installed in the Section shall be in accordance with FAA C-1217f, FAA STD-019e and FAA Order 6950.19a.
- B. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
 - 2. Make connections with clean bare metal at points of contact.
 - 3. Coat and seal connections involving dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - 4. Indoor exothermic welds shall be smokeless type.
- C. Exothermic Welded Connections: Use for connections to structural steel. Comply with manufacturer's written recommendations. Welds are puffed up or shown convex surfaces indicating improper cleaning are not acceptable.
- D. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs.
- E. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, or at non-metallic or non-conductive housings, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors shall be bonded.
- F. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torque requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A.
- G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Mechanical connections using a Burndy "Hyground Connector" or equipment when operated at a force of 24,000 pounds are acceptable as FAA approved pressure connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on ground conductor. Hydraulically crimped connectors are not acceptable in a lightning protection system.

3.4 SYSTEM AND EQUIPMENT GROUNDING

- A. Install grounding conductor(s) in each conduit carrying branch or feeder conductors and in conduit for control wiring. Each over current device shall have its own individual grounding

conductor. Grounding conductor shall have insulation rating equivalent to phase conductor insulation. Insulated grounding conductors shall be connected to the ground terminal at both ends and to junction, transition, pull and fixtures boxes along the route. Under no circumstances shall this conductor be omitted from the electrical system, nor shall a separate grounding system, such as the equipment grounding or signal grounding, be used as a substitute.

- B. Metallic raceway housing the equipment grounding conductor shall be electrically continuous.
- C. Where there are parallel conductors of a feeder installed in more than one raceway, install an equipment grounding conductor in each raceway.
- D. Ground the ends of all conduit runs using grounding bushings, except for receptacle and lighting branch circuits.
- E. Splices of grounding conductors inside conduits are not acceptable.

3.5 FIELD QUALITY CONTROL

- A. Independent Testing Organization: Arrange and pay for the services of a qualified independent electrical testing organization to perform tests described below.
- B. Tests:
 - 1. Subject the completed grounding system to a megger test at each location where a maximum ground resistance level is specified.
- C. Bolting Resistance: Spot test to verify that ground cable bolted connections have a DC resistance of maximum one milliohm, when measured with a bridge type milliohmeter or similar instrument.
- D. Continuity: Test grounding conductors, sheet metal, metallic conduits, equipment enclosure, metallic enclosures, and lighting fixtures for continuity to grounding system.
- E. Deficiencies: Where ground resistances exceed specified values, modify the grounding system to reduce resistance values. Where measures are directed that exceed those indicated the provisions of the Contract, covering changes will apply.
- F. Report: Prepare test reports, certified by the testing organization, of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

END OF SECTION 16452